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(54) **ABNORMAL MEASUREMENT DETECTION DEVICE AND METHOD FOR INFRARED RADIATION THERMOMETER**

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G01J 5/08	(2006.01)

(Continued)

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CPC ***G01J 5/0003*** (2013.01); ***G01J 5/0044*** (2013.01); ***G01J 5/02*** (2013.01); ***G01J 5/026*** (2013.01); ***G01J 5/04*** (2013.01); ***G01J 5/043*** (2013.01); ***G01J 5/08*** (2013.01); ***G01J 5/0803*** (2013.01); ***G01J 5/0846*** (2013.01); ***G01J 5/0859*** (2013.01); ***G01J 5/12*** (2013.01); ***G01J 5/522*** (2013.01); *G01J 2005/0077* (2013.01); *G01J 2005/0081* (2013.01)

(58) **Field of Classification Search**

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USPC 374/1, 2, 100

See application file for complete search history.

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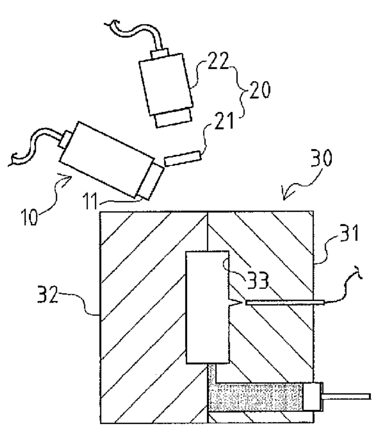
(57) **ABSTRACT**

A technique for an infrared radiation thermometer used for thermography that detects measurement abnormality of an infrared radiation thermometer and estimates the causes of the measurement abnormality such as contamination of an objective lens and a malfunction in a mechanism section of the infrared radiation thermometer.

2 Claims, 4 Drawing Sheets



(51) **Int. Cl.**

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G01J 5/04	(2006.01)
G01J 5/52	(2006.01)

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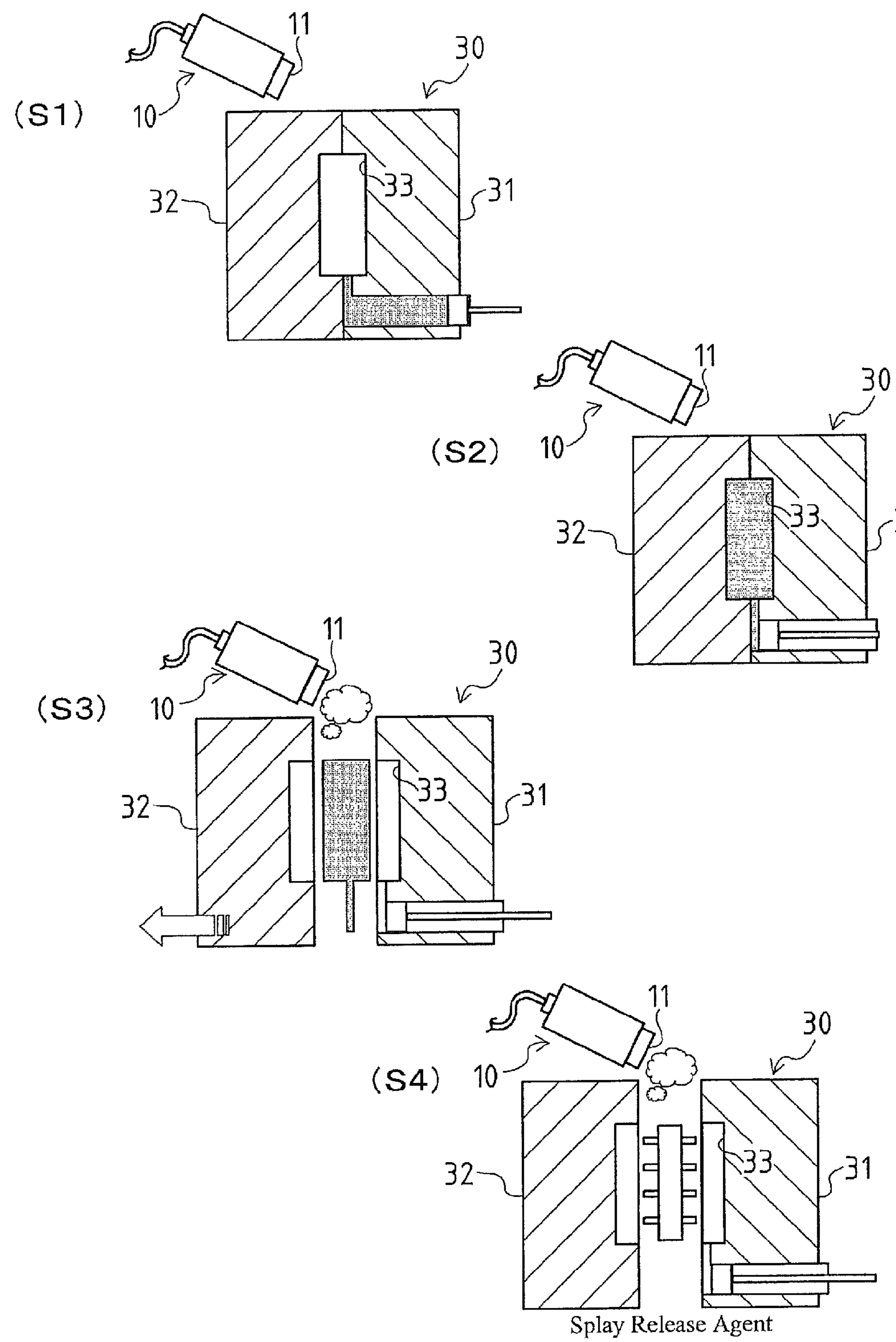
F I G. 1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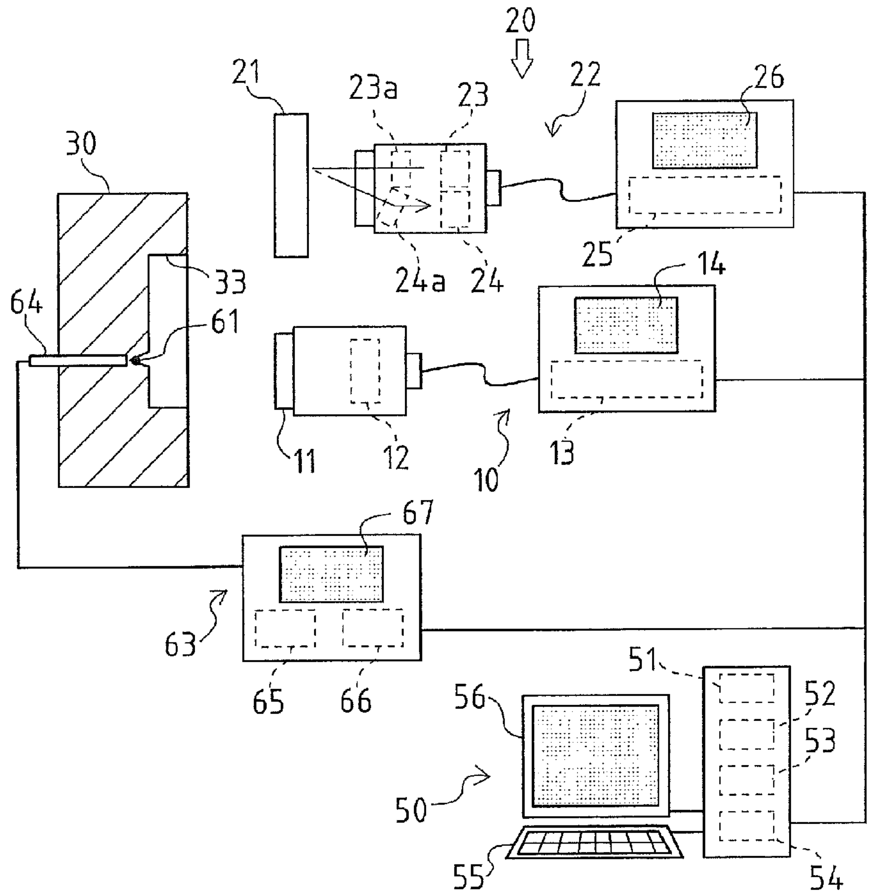
31
Splay Release Agent

F I G. 2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F I G. 3

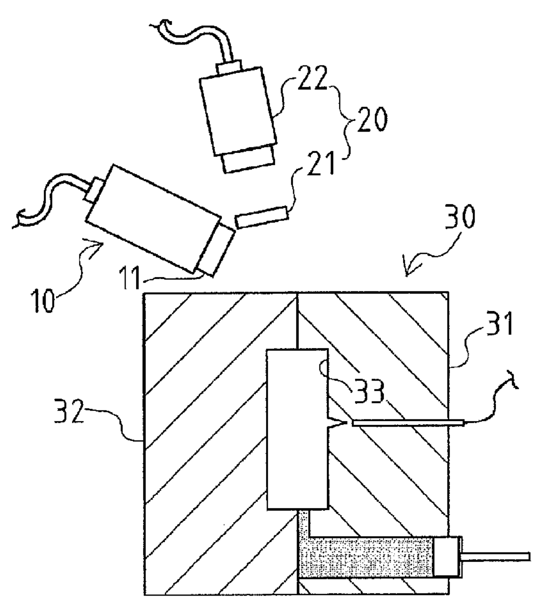
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FIG. 4

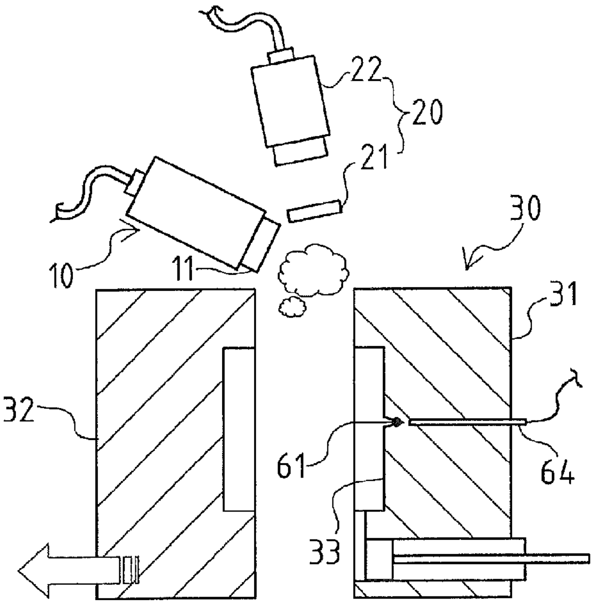


FIG. 5

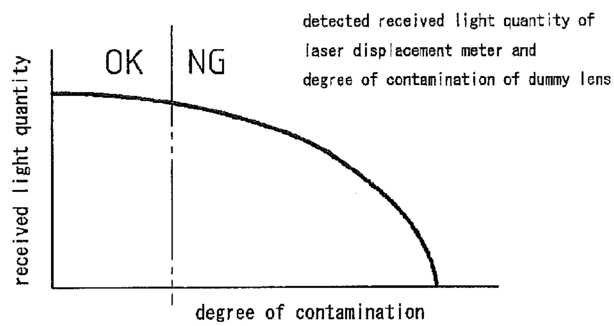
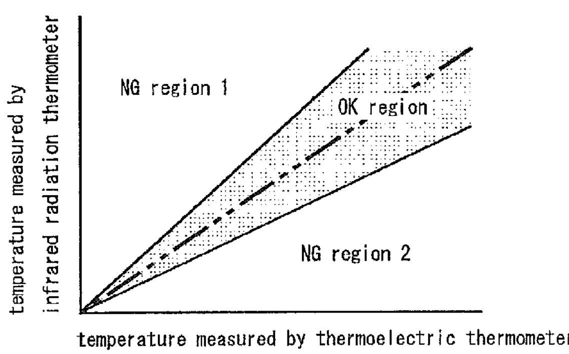
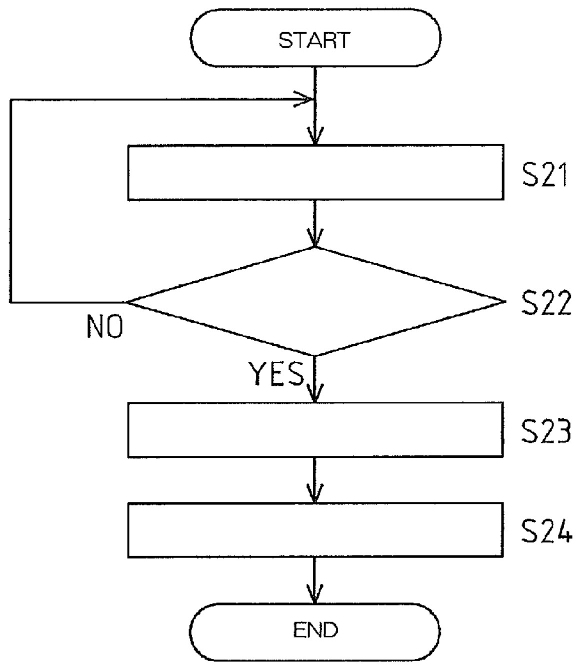


FIG. 6



F I G. 7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S22
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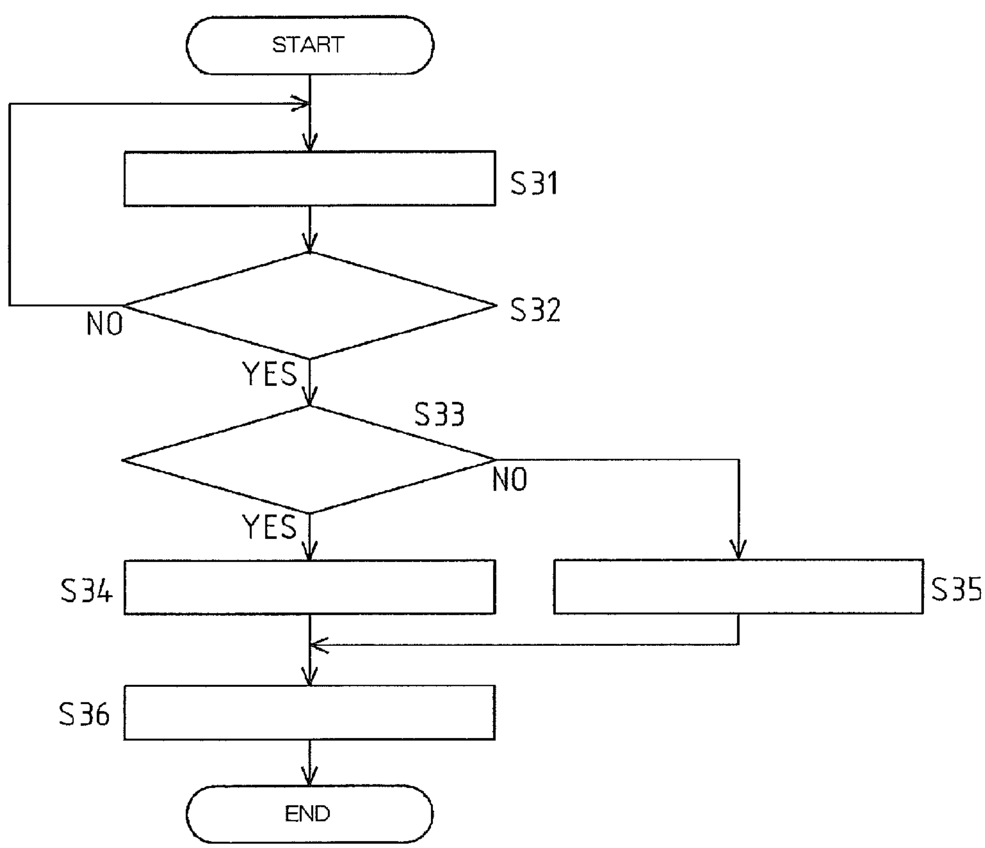
S23
S24
END

F I G. 8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S33
NO
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S34
S35
S36
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ABNORMAL MEASUREMENT DETECTION DEVICE AND METHOD FOR INFRARED RADIATION THERMOMETER

This is a division of application Ser. No. 12/593,541 filed 28 Sep. 2009, which is a 371 national phase application of PCT/JP2008/056283 FILED 25 Mar. 2008, which claims priority to Japanese Patent Application No. 2007-094131 filed 30 Mar. 2007, the contents of which are incorporated herein by reference.

TECHNICAL FIELD

The present invention relates to an art preventing measurement abnormality of an infrared radiation thermometer previously and detecting the measurement abnormality with regard to temperature measurement with the infrared radiation thermometer.

BACKGROUND ART

Conventionally, in various fields such as engineering and medical science, thermography is used to measure surface temperature of a measurement object noncontactingly. The thermography shows temperature distribution of a surface of an object or an organism as an image, and temperature detected by an infrared radiation thermometer is grasped as a change of electrical characteristics and is re-converted into strength of light and outputted as an image, whereby continuous temperature distribution of the surface of the measurement object can be observed.

For example, in the infrared radiation thermometer, (1) infrared radiation from a measurement object is condensed through a lens and focalized at a detecting element, (2) an electric signal corresponding to the strength of the infrared radiation is obtained from the detecting element, and (3) the signal is amplified, linearizedly revised and emissively revised by, and then displayed and outputted.

Such thermography is also used in the field of casting so as to measure temperature of a cavity of a casting mold.

Explanation will be given on an example of the casting processes referring FIG. **1**. For example, the casting processes are performed in steps S**1** to S**4** shown in FIG. **1**. A mold **30** is clamped (step S**1**), melted metal is injected into a cavity **33** so as to form a product (step S**2**), the mold is opened and the product is taken out from the mold **30** (step S**3**), the cavity **33** is splayed thereto with release agent and then dried by air blow (step S**4**), and then the mold **30** is clamped again (step S**1**) and the casting processes are shifted to the next cycle.

In the above casting processes, at the time of opening the casting mold, temperature of the cavity is measured with an infrared radiation thermometer **10**. However, at the time of opening the casting mold, smoke, oil mist, the release agent and the like are scattered, whereby an objective lens **11** of the thermometer **10** is adhered thereto with oil, dust and the like and is contaminated. Accordingly, dirt is accumulated on the objective lens **11** of the thermometer **10** so as to cause measurement abnormality. Then, it is necessary to clean the surface of the objective lens **11** timely.

For preventing contamination of a lens of an infrared radiation thermometer, the JP-U-3041996 discloses an art of an infrared radiation thermometer that a protection filter is detachably attached at a position before an objective lens so as to prevent adhesion of oil, dust and the like to the objective lens and to perform check of contamination and cleaning work quicldy.

However, in the casting, at the time of measuring the temperature of the cavity of the casting mold, the objective lens of the infrared radiation thermometer may be positioned at a position difficult to be viewed by an operator, such as a position above the casting mold or a position with high temperature. In this case, it is difficult to judge whether the measurement abnormality is caused by the contamination of the objective lens actually or not. For preventing the measurement abnormality caused by the contamination of the objective lens, the surface of the objective lens may be cleaned usually, but it is not productive.

The present invention proposes an art of the infrared radiation thermometer used for thermography that measurement abnormality is detected and the cause of the measurement abnormality, such as contamination of the objective lens, defect of the mechanical part of the infrared radiation thermometer or the like, is estimated.

DISCLOSURE OF THE INVENTION

An measurement abnormality detection device for an infrared radiation thermometer, which is the first aspect of the present invention, includes a dummy lens, received light quantity measurement means and a determination means. The dummy lens is placed around an objective lens of the infrared radiation thermometer and arranged at a position and in an attitude that are more susceptible to contamination than the objective lens. The received light quantity measurement means for projecting light to the dummy lens at predetermined intervals or at a predetermined timing, for receiving the light reflected by the dummy lens, and for measuring received light quantity. The determination means calculate an attenuation rate of the projected light on the basis of the received light quantity measured by the received light quantity measurement means, estimates degree of contamination of the dummy lens on the basis of the calculated attenuation rate, and judges necessity of warning for contamination of the objective lens on the basis of the degree of contamination of the dummy lens.

An measurement abnormality detection device for an infrared radiation thermometer, which is the second aspect of the present invention, provided with a dummy lens, a received light quantity measurement means and a determination means. The dummy lens is placed around an objective lens of the infrared radiation thermometer so as to be at a position and in an attitude that are more susceptible to contamination than the objective lens. The determination means is connected to the received light quantity measurement means. The method includes a step that the received light quantity measurement means projects light to the dummy lens at predetermined intervals or at a predetermined timing, receives the light reflected by the dummy lens, and measures received light quantity, and a step that the determination means calculates attenuation rate of the projected light on the basis of the measured received light quantity, estimates degree of contamination of the dummy lens on the basis of the calculated attenuation rate, and judges, on the basis of the degree of contamination of the dummy lens, the necessity of warning for contamination of the objective lens.

An measurement abnormality detection device for an infrared radiation thermometer, which is the third aspect of the present invention, comprises a thermoelectric thermometer and a determination means. The thermoelectric thermometer measures temperature of a dummy black body point set at a part which can be regarded as a black body in a measurement object of the infrared radiation thermometer. The determination means obtains temperatures of the dummy black body point measured by the thermoelectric thermometer and by the infrared radiation thermometer, detects measurement abnormality on the basis of difference between these measured temperatures, and, when the measurement abnormality is detected, judges whether a defect exists in the infrared radiation thermometer or the thermoelectric thermometer on the basis of relation between the temperatures measured by the thermoelectric thermometer and by the infrared radiation thermometer.

An measurement abnormality detection device for an infrared radiation thermometer, which is the forth aspect of the present invention, provided with a thermoelectric thermometer and a determination means. The thermoelectric thermometer measures temperature of a dummy black body point set at a part which can be regarded as a black body in a measurement object of the infrared radiation thermometer. The determination means is connected to the infrared radiation thermometer and the thermoelectric thermometer. The method includes a step that temperature of the dummy black body point is measured by the infrared radiation thermometer and the thermoelectric thermometer, and a step that the determination means obtains the temperature measured by the thermoelectric thermometer and the temperature measured by the infrared radiation thermometer, detecting measurement abnormality on the basis of difference between these measured temperatures, and, when the measurement abnormality is detected, judges whether a defect exists in the infrared radiation thermometer or the thermoelectric thermometer on the basis of relation between the temperatures measured by the thermoelectric thermometer and by the infrared radiation thermometer.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a drawing of casting processes.

FIG. **2** is a drawing of an infrared radiation thermometer according to the present invention and devices provided therewith.

FIG. **3** is a drawing of an embodiment of a lens contamination detection mechanism and a thermoelectric thermometer according to the present invention.

FIG. **4** is a drawing of the embodiment of the lens contamination detection mechanism and the thermoelectric thermometer according to the present invention.

FIG. **5** is a diagram of relation between received light quantity and degree of contamination of a dummy lens.

FIG. **6** is a diagram of relation between measured temperatures of the infrared radiation thermometer and the thermoelectric thermometer.

FIG. **7** is a flow chart of an embodiment of contamination detection of an objective lens by a determination means according to the present invention.

FIG. **8** is a flow chart of an embodiment of detection of measurement abnormality by the determination means according to the present invention.

THE BEST MODE FOR CARRYING OUT THE INVENTION

As shown in FIG. **2**, an infrared radiation thermometer **10**, which is an embodiment of an infrared radiation thermometer according to the present invention, measures surface temperature of a cavity **33** of a mold **30**. The thermometer **10** is provided therein with an measurement abnormality detection device, the device containing a lens contamination detection mechanism **20** for detecting contamination of a lens, a thermoelectric thermometer **63** for measuring temperature of the mold **30**, which is a measurement object of the thermometer **10**, and a determination means **50** electrically connected to the thermometer **10**, the lens contamination detection mechanism **20** and the thermometer **63**.

According to the measurement abnormality detection device, when contamination of an objective lens **11** of the thermometer **10** is notified or measurement abnormality occurs, it is specified whether the defect is caused by the thermometer **10** or the measurement abnormality detection device.

In this embodiment, the infrared radiation thermometer **10** and the measurement abnormality detection device are provided with the mold **30**. However, the application is not limited thereto, and for example the devices may alternatively be provided with a pressing machine so as to measure temperature of a pressed product.

Explanation will be given on the mold **30** with which the thermometer **10** and the measurement abnormality detection device are provided.

As shown in FIGS. **3** and **4**, the mold **30** has a fixed mold **31**, a movable mold **32** which can be moved close to or apart from the fixed mold **31**, and the like. When the mold **30** is clamped (the fixed mold **31** is mated closely with the movable mold **32**), the cavity **33** in which a casting is molded is formed in a mating surface between the fixed mold **31** and the movable mold **32**.

The reflectance of the surface of the cavity **33** is preferably small. Then, for reducing the reflectance of the surface of the cavity **33**, for example carbon fullerene which is a black substance may be applied thereto. The carbon fullerene is known not to affect the mold **30** and the castings. The carbon fullerene hardly peels off from the mold **30** at the time of casting and is easily applied again if the carbon fullerene peels off. Accordingly, the carbon fullerene is suitable as a black substance to be applied to the cavity **33**.

By applying a thing with low reflectance to the cavity **33** as mentioned above, measurement accuracy is improved in the case of measurement of temperature of the mold **30** with the thermometer **10**. That is because the high reflectance of the cavity **33** of the new mold **30**, which is lustrous silver, can be reduced by applying the black substance, and color shading, which occurs on the cavity **33** of the mold **30** according to use status, can be reduced by applying the black substance, whereby the surface status of the cavity **33** is substantially fixed regardless of newness or oldness and use status of the mold **30**.

By applying the black substance to the cavity **33**, seizure of the mold **30** can be reduced.

Explanation will be given on the construction of the thermometer **10**.

The thermometer **10** is provided so as to measure the surface temperature of the cavity **33** of the new mold **30** noncontactingly and nondestructively.

As shown in FIGS. **2** to **4**, the thermometer **10** has the objective lens **11**, a detecting element **12**, an operation part **13** and an output part **14**. The objective lens **11** of the thermometer **10** is arranged at the position at which the cavity **33**, exposed on the mating surface between the fixed mold **31** and the movable mold **32** in the state that the mold **30** is opened (the fixed mold **31** and the movable mold **32** are separated), can be imaged.

With regard to the thermometer **10**, infrared radiation radiated from a measurement object is condensed by the objective lens **11**, focalized at the detecting element **12**, and exchanged to an electric signal corresponding to the magnitude of the infrared radiation by the detecting element **12**. The electric signal is amplified, linearizedly revised and emissively revised by the operation part **13**, and then displayed and outputted by the output part **14**.

However, the construction of the thermometer **10** is not limited to the above-mentioned construction, and a commonly obtainable infrared radiation thermometer may be used.

Explanation will be given on the lens contamination detection mechanism **20**.

In the measurement abnormality detection device, as the lens contamination detection mechanism **20** detecting degree of contamination of the objective lens **11** of the thermometer **10**, a dummy lens **21** and a laser displacement meter **22** are provided.

As shown in FIGS. **2** to **4**, the dummy lens **21** is placed in the periphery of the objective lens **11** of the thermometer **10** so as to be arranged at a position and in an attitude those are more susceptible to contamination than the objective lens **11**. In detail, the dummy lens **21** is placed at a position and in an attitude those are close to the objective lens **11** of the thermometer **10** and more susceptible to be adhered thereto by gas, scattering thing and the like emitted from the cavity **33** of the new mold **30** so as to be not less susceptible to contamination than the objective lens **11**.

As the dummy lens **21**, a member is adopted which is translucent, is hardly scared, and is not heat-distorted and reacted by gas, scattering thing and the like emitted from the cavity **33** of the new mold **30** (for example, a glass lens).

Then, the laser displacement meter **22** is provided at a position far from the dummy lens **21** for predetermined distance. As the laser displacement meter **22**, a commonly obtainable laser displacement meter can be used. The distance between the dummy lens **21** and the laser displacement meter **22** is preferable short so as to improve the accuracy.

The laser displacement meter **22** is adopted to the lens contamination detection mechanism **20** as an embodiment of a received light quantity measurement means which projects light to the dummy lens **21** at each predetermined time or at a predetermined timing, receives the light reflected by the dummy lens **21**, and measures the received light quantity (intensity).

Then, instead of the laser displacement meter **22**, any member can be adopted which can project light to the dummy lens **21** and detect quantity of light reflected by the dummy lens **21**. For example, an illuminant and a luminance meter may be provided so that the illuminant projects light to the dummy lens **21** and the luminance meter measures quantity of light reflected by the dummy lens **21**.

Since the dummy lens **21** is translucent, a part of light projected to the dummy lens **21** is transilluminated, another part thereof is absorbed, and the other part thereof is reflected. As shown in FIG. **5**, there is known that the larger the degree of contamination of the dummy lens **21** is, the small the received light quantity detected by the laser displacement meter **22** is. Then, the laser displacement meter **22** is provided so as not to measure the displacement from the laser displacement meter **22** to the dummy lens **21** but to measure the degree of contamination of the dummy lens **21** on the basis of the change of the received light quantity detected by the laser displacement meter **22** (attenuation quantity) in the state that the distance between the dummy lens **21** and the laser displacement meter **22** is substantially fixed. In the lens contamination detection mechanism **20**, on the basis of the degree of contamination of the dummy lens **21**, the degree of contamination of the objective lens **11** of the thermometer **10** is estimated.

The laser displacement meter **22** has a luminous element **23**, a photo detection element **24**, an operation part **25** and an output part **26**. Laser light projected from the luminous element **23** is condensed through a floodlight lens **23***a* and is irradiated to the dummy lens **21**. A part of the light diffusively reflected by the dummy lens **21** is detected by the photo detection element **24** through a photo detection lens **24***a*. The received light quantity (light intensity) detected by the photo detection element **24** is calculated by the operation part **25**, displayed and outputted by the output part **26** and transmitted to the determination means **50** discussed later.

With regard to the lens contamination detection mechanism **20**, the object of contamination detection is not the objective lens **11** of the thermometer **10** but the dummy lens **21**. Accordingly, when the thermometer **10** is exchanged with another device, the lens contamination detection mechanism **20** can be used continuously. Maintenance of the thermometer **10** because of the lens contamination or the like may be performed as an outside order by a specialist. Then, the construction that the lens contamination detection mechanism **20** is independent of the thermometer **10** is suitable on the point that casting can be continued only by exchanging the thermometer **10**.

Explanation will be given on the thermometer **63** which is an embodiment of the thermoelectric thermometer according to the present invention.

As shown in FIGS. **2** to **4**, the thermoelectric thermometer **63** measuring the temperature of the mold **30** is provided in the measurement abnormality detection device so as to detect the measurement abnormality of the thermometer **10**. Both the thermometers **63** and **10** measure temperature of a dummy black body point **61** set at a part which can be regarded as a black body in the mold **30** being the measurement object of the infrared radiation thermometer **10**.

The dummy black body point **61** is set in or near the cavity **33** of the mold **30** at a part having shape absorbing infrared radiation (preferably, cone shape) or a part the most close to the black body of the cavity **33** being the measurement object in the shape characteristics. Accordingly, the dummy black body point **61** is provided in or near the cavity **33** of the mold **30** being the measurement object of the thermometer **10**, whereby the measurement abnormality of the thermometer **10** can be detected accurately.

In this embodiment, a cone hole **62** is provided in or near the cavity **33** of the mold **30**, and the bottom of the hole **62** is regarded as the dummy black body point **61**. The dummy black body point **61** can be provided in the mold **30** by using a cone hole existing in the inner peripheral shape of the cavity **33** or by forming a cone hole newly near the cavity **33**.

In addition, when the dummy black body point **61** is difficult to be provided in the mold **30**, it may alternatively be constructed that a jig holding a thermocouple **64** of the thermometer **63** and the dummy black body point **61** is set in the jig.

The thermometer **63** has the thermocouple **64**, a detection part **65**, an operation part **66** and an output part **67**. Electromotive force generated in the thermocouple **64** is detected by the detection part **65**. The temperature is calculated by the operation part **66** on the basis of the detected electromotive force, and is displayed and outputted by the output part **67** and transmitted to the determination means **50** discussed later.

The thermometer **63** is provided so as to measure the temperature of the dummy black body point **61**. However, it is difficult to measure the temperature of the dummy black body point **61** itself actually. Then, the thermocouple **64** is arranged near the dummy black body point **61**, and the thermometer **63** measures temperature more close to the temperature of the dummy black body point **61** of the mold **30**.

Explanation will be given on the construction of the determination means **50** which is an embodiment of the determination means according to the present invention.

As shown in FIG. **2**, the thermometer **10** and the lens contamination detection mechanism **20** are connected to the determination means **50** so as to enable transmission of information. The determination means **50** obtain the information from these members so as to detect the contamination of the objective lens **11** of the thermometer **10**, to judge whether the contamination of the objective lens **11** is necessary to be notified or not, and to judge the measurement abnormality of the thermometer **10**.

The determination means **50** is a so-called electronic calculator. The electronic calculator has a control part **51**, an operation part **52**, a storage part **53**, an input/output part **54**, an operation input part **55** and an output part **56**. These members are connected mutually through a bus for mutual exchange of information under the control of the control part **51**.

The control part **51** manages the actuation control of the whole determination means **50**. The operation part **52** reads out various application programs stored in the storage part **53** and executes them so as to show the function of the determination means **50**. The storage part **53** stores the various application programs and data. The input/output part **54** transmits data to and receives data from an outside device for example through an optional network, and obtains information from the thermometer **10**, the lens contamination detection mechanism **20** and a temperature revision device **60** and transmits signals to these members. The operation input part **55** is such as a keyboard or a mouse so as to input information to the determination means **50**. The output part **56** is a display or a speaker outputting results of the processing of the determination means **50**.

Explanation will be given on the processing of the determination means **50** obtaining measurement output value of the laser displacement meter **22** referring FIG. **7**.

In the determination means **50**, quantity (intensity) of light projected to the dummy lens **21** is set by the laser displacement meter **22**. When the casting is started, the laser displacement meter **22** projects light to the dummy lens **21** at each predetermined time or at a predetermined timing and receives the light reflected by the dummy lens **21** so as to measure the received light quantity.

In the determination means **50**, when the output value of the laser displacement meter **22** is obtained (S**21**), the decrement of the projected light is calculated on the basis of the output value (light quantity). Successively, in the determination means **50**, the decrement is compared with a threshold set previously (S**22**) so as to estimate the degree of contamination of the dummy lens. The threshold is the decrement in the case that the objective lens **11** of the thermometer **10** is contaminated and accurate measurement value cannot be obtained so that the contamination of the lens must be notified, and is found experimentally and set in the determination means **50** previously.

Then, the determination means **50** judges whether the contamination of the objective lens is necessary to be notified or not on the basis of the degree of contamination of the dummy lens. Namely, when the decrement is larger than the threshold (YES at S**22**), the contamination of the objective lens is judged necessary to be notified (S**23**) and the notice is outputted through display or voice by the output part **56** (S**24**). It is timely to clean the objective lens **11** of the thermometer **10** at the time at which the notice is outputted. An operator may clean or exchange the objective lens **11** of the thermometer **10**, or alternatively, a cleaning means such as a wiper for the objective lens **11** and the dummy lens **21** may be provided so as to clean them automatically.

As mentioned above, the dummy lens **21** is placed at the position and in the attitude that are more susceptible to contamination than the objective lens **11** of the thermometer **10** so that the dummy lens **21** is contaminated sooner than the objective lens **11** and the degree of contamination of the dummy lens **21** is larger than the objective lens **11**. Therefore, the measurement abnormality of the thermometer **10** caused by the contamination of the objective lens **11** does not occur before the determination means **50** judges necessary to clean the objective lens **11** of the thermometer **10**, thereby preventing the measurement abnormality previously.

In addition to the contamination of the objective lens **11** of the thermometer **10**, the lens contamination detection mechanism **20** may be used for detecting disturbance factors such as sunlight so as to prevent the measurement abnormality previously.

Explanation will be given on the processing of the determination means **50** obtaining measured temperature of the thermometer **63** and measured temperature of the thermometer **10** referring FIG. **8**.

With regard to the casting processes shown in FIG. **1**, in the state that the mold **30** is opened (steps S**3** and S**4**), the temperature of the dummy black body point **61** is measured by both the thermometer **10** and the theimometer **63** substantially simultaneously at each predetermined time or at a predetermined timing.

When the temperature of the dummy black body point **61** measured by the thermometer **63** and the temperature of the dummy black body point **61** measured by the thermometer **10** are obtained in the determination means **50** (S**31**), the determination means **50** comparatively operates these measured temperatures (S**32**), and the measurement abnormality is detected on the basis of the difference of the measured temperatures. When the difference of the measured temperatures of the thermometer **10** and the thermometer **63** is larger than the threshold (YES at S**32**), the determination means **50** judges that the measurement abnormality occurs.

When the measurement abnormality is detected, the determination means **50** judges whether the defect exists in the functional part of the thermometer **10** (the part except for the objective lens **11**) or the thermometer **63** on the basis of the relation between the measured temperature of the thermometer **63** and the measured temperature of the thermometer **10**.

At this time, the determination means **50** judges whether the defect exists in an NG region **1** or an NG region **2** discussed later on the basis of the tendency of the measurement abnormality, that is, the magnitude relation between the measured temperature of the thermometer **10** and the measured temperature of the thermometer **63**.

As shown in FIG. **6**, concerning the relation between the measured temperature of the thermometer **10** and the measured temperature of the thermometer **63**, an OK region and an NG region are set and stored in the storage part **53** of the determination means **50** previously. With regard to the NG region, the NG region in which the measured temperature of the thermometer **10** is larger than the measured temperature of the thermometer **63** is regarded as the NG region **1**, and the NG region in which the measured temperature of the thermometer **10** is larger than the measured temperature of the thermometer **63** is regarded as the NG region **2**.

When the tendency of the measurement abnormality exists in the NG region **1** (YES at S**33**), the determination means **50** judges that the abnormality exists in the functional part of the thermometer **10** (S**34**). As the cause of this measurement abnormality, for example, defect of the detecting element **12** or the operation part **13** of the thermometer **10** can be given.

On the other hand, when the tendency of the measurement abnormality exists in the NG region **2** (NO at S**33**), it is judged that the abnormality exists in the thermometer **63** (S**35**). As the cause of this measurement abnormality, for example, break of the thermocouple **64** can be given.

The judgment result of the determination means **50** is outputted through display or voice by the output part **56** as the notification of measurement abnormality (S**36**).

With regard to the measurement abnormality detection device according to this embodiment, the measured result is outputted from each of the laser displacement meter **22** and the thermometer **63** to the one determination means **50**. According to this construction, the process in the case that the output is obtained from the laser displacement meter **22** and the process in the case that the output is obtained from the thermometer **10** and the thermometer **63** are performed inclusively by the determination means **50**, thereby judging whether the measurement abnormality of the thermometer **10** is caused by the contamination of the objective lens **11** of the thermometer **10**, the defect of the functional part of the thermometer **10**, or the defect of the thermometer **63**.

Namely, in the determination means **50**, when the decrement of the output value obtained from the laser displacement meter **22** (received light quantity) is not larger than the predetermined threshold and the difference of measured temperatures of the thermometer **10** and the thermometer **63** is larger than the predetermined threshold, the defect of the thermometer **10** or the thermometer **63** is notified on the basis of whether the tendency of the measurement abnormality exists in the NG region **1** or the NG region **2**. On the other hand, when the difference of measured temperatures of the thermometer **10** and the thermometer **63** is not larger than the predetermined threshold and the decrement of the output value obtained from the laser displacement meter **22** (received light quantity) is larger than the predetermined threshold, the contamination of the objective lens **11** of the thermometer **10** is notified.

Accordingly, the determination means **50** can detect the measurement abnormality of the infrared radiation thermometer and estimate the cause thereof, whereby the functional part or the objective lens **11** of the infrared radiation thermometer **10**, the lens contamination detection mechanism **20** or the thermoelectric thermometer **63** can be maintained efficiently.

Industrial Applicability

The present invention is available of temperature measurement with an infrared radiation thermometer and is especially suitable for an art preventing measurement abnormality of the infrared radiation thermometer previously and detecting the measurement abnormality.

The invention claimed is:

1. A measurement abnormality detection device for an infrared radiation thermometer for measuring a casting mold comprising:

a thermoelectric thermometer for measuring temperature of a dummy black body point set in a cone hole existing on an inner surface of a cavity of the mold as a part having a shape absorbing infrared radiation or a part most close in shape characteristics to a black body in the mold; and

a determination device that obtains temperatures of the dummy black body point measured by the thermoelectric thermometer and by the infrared radiation thermometer, and detects measurement abnormality on the basis of a difference between these measured temperatures,

wherein the determination device is programmed to distinguish between a defect in the infrared radiation thermometer and a defect in the thermoelectric thermometer and accordingly judge, when the measurement abnormality is detected, whether

the ratio of the temperature measured by the infrared radiation thermometer to the temperature measured by the thermoelectric thermometer exceeds an upper threshold value which indicates a defect in the thermoelectric thermometer, or

the ratio is below a lower threshold which indicates a defect in the infrared radiation thermometer.

2. A measurement abnormality detection method for an infrared radiation thermometer for measuring a casting mold comprising:

preparing a thermoelectric thermometer for measuring temperature of a dummy black body point set in a cone hole existing on an inner surface of a cavity of the mold as a part having a shape absorbing infrared radiation or a part most close in shape characteristics to a black body in the mold and a determination device connected to the infrared radiation thermometer and the thermoelectric thermometer;

measuring temperature of the dummy black body point with the infrared radiation thermometer and the thermoelectric thermometer; and

obtaining the temperatures measured by the thermoelectric thermometer and by the infrared radiation thermometer,

detecting measurement abnormality on the basis of a difference between these measured temperatures,

distinguishing between a defect in the infrared radiation thermometer and a defect in the thermoelectric thermometer, and

judging, when the measurement abnormality is detected, whether

the ratio of the temperature measured by the infrared radiation thermometer to the temperature measured by the thermoelectric thermometer exceeds an upper threshold value which indicates a defect in the thermoelectric thermometer, or

the ratio is below a lower threshold which indicates a defect in the infrared radiation thermometer.

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